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THE FIRM REDSHIFT LOWER LIMIT OF THE MOST DISTANT TeV-DETECTED BLAZAR PKS 1424+240

A. Furniss[1], D. A. Williams[1], C. Danforth[2], M. Fumagalli[3,4,9], J. X. Prochaska[5], J. Primack[1], C. M. Urry[6], J. Stocke[2], A. V. Filippenko[7], and W. Neely[8]
[1] Santa Cruz Institute of Particle Physics, and Department of Physics, University of California Santa Cruz, 1156 High Street, Santa Cruz, CA 95064, USA
[2] CASA, Department of Astrophysical and Planetary Sciences, University of Colorado, 389-UCB, Boulder, CO 80309, USA
[3] Carnegie Observatories, 813 Santa Barbara Street, Pasadena, CA 91101, USA
[4] Department of Astrophysics, Princeton University, Princeton, NJ 08544-1001, USA
[5] Department of Astronomy and Astrophysics, UCO/Lick Observatory, University of California, 1156 High Street, Santa Cruz, CA 95064, USA
[6] Department of Astronomy, Yale University, New Haven, CT 06520-8120, USA
[7] Department of Astronomy, University of California, Berkeley, CA 94720-3411, USA
[8] NF/Observatory, Silver City, NM 88041, USA
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ABSTRACT

We present the redshift lower limit of $z \geqslant 0.6035$ for the very high energy (VHE; $E \geqslant 100$ GeV) emitting blazar PKS 1424+240 (PG 1424+240). This limit is inferred from Lyβ and Lyγ absorption observed in the far-ultraviolet spectra from the *Hubble Space Telescope*/Cosmic Origins Spectrograph. No VHE-detected blazar has shown solid spectroscopic evidence of being more distant. At this distance, VHE observations by VERITAS are shown to sample historically large gamma-ray opacity values at 500 GeV, extending beyond $\tau = 4$ for low-level models of the extragalactic background light (EBL) and beyond $\tau = 5$ for high levels. The majority of the $z = 0.6035$ absorption-corrected VHE spectrum appears to exhibit a lower flux than an extrapolation of the contemporaneous Large Area Telescope power-law fit beyond 100 GeV. However, the highest energy VERITAS point is the only point showing agreement with this extrapolation, possibly implying the overestimation of the gamma-ray opacity or the onset of an unexpected VHE spectral feature. A curved log parabola is favored when fitting the full range of gamma-ray data (0.5–500 GeV). While fitting the absorption-corrected VHE data alone results in a harder differential power law than that from the full range, the indices derived using three EBL models are consistent with the physically motivated limit set by Fermi acceleration processes.

Key words: BL Lacertae objects: individual (PKS 1424+240 (PG 1424+240)) – diffuse radiation – galaxies: active – intergalactic medium – ultraviolet: general

Online-only material: color figures

1. INTRODUCTION

Blazars are active galaxies with a jet closely aligned with the Earth line of sight (Urry & Padovani 1995). These objects are the most commonly detected type of extragalactic source at very high energy (VHE; $E \geqslant 100$ GeV). The VHE gamma rays that propagate through the intergalactic medium (IGM) are absorbed by extragalactic background light (EBL) photons via pair production (Nikishov 1962; Gould & Shréder 1967). The EBL is difficult to directly measure due to strong foreground sources (Hauser & Dwek 2001).

Various methods are used to estimate the density of the EBL. A selection of EBL models includes a semi-analytical model (Gilmore et al. 2012), an observationally based model that utilizes observations of *K*-band rest-frame galaxy luminosity functions in combination with galaxy spectral energy distribution fractions (Domínguez et al. 2011), and a model based on starlight emission and dust re-emission templates (Finke et al. 2010). Each of these estimated photon densities are above the lower limits set by galaxy counts (Werner et al. 2004) and below the limits set by detection of extragalactic VHE photons (e.g., Aharonian et al. 2006).

The interaction between VHE and EBL photons produces a "gamma-ray horizon," limiting the distance to which VHE sources can be detected. 3C 279 is the most distant VHE emitting blazar with a spectroscopically measured redshift. By spectroscopically measured, we mean the detection of emission and/or absorption lines of the host galaxy. 3C 279 is a flat-spectrum radio quasar (FSRQ) at $z = 0.536$ (Marziani et al. 1996) and was observed above 50 GeV by MAGIC during a flare (Albert et al. 2008).

FSRQs are blazars that show emission lines with an equivalent width of $\geqslant$5 Å, providing strong host-galaxy emission and absorption for spectroscopic distance measurements. Conversely, BL-Lacertae-type blazars display weak or no emission/absorption lines, and lack evidence for a Ca H+K break in their optical spectrum (Marcha et al. 1996; Healey et al. 2007). With this definition, it is not surprising that there are VHE-detected BL Lac objects that lack definite spectroscopic redshift measurements. Some notable VHE blazars without spectroscopic redshift are KUV 00311−1938, PG 1553+113, 3C 66A, S5 0716+714, and PKS 1424+240 (PG 1424+240).

KUV 00311−1938, detected at TeV energies by H.E.S.S. (Becherini et al. 2012), has a tentative redshift of 0.61 from the observation of five features in a poor signal-to-noise ratio (S/N) spectrum (Piranomonte et al. 2007). Follow-up spectroscopy with improved S/N did not confirm any $z = 0.61$ features, although an intervening Mg II absorption system at $z = 0.506$, not visible in the previous spectrum, was observed and sets a lower limit on the blazar distance (Pita et al. 2012).

Since BL Lac objects display bright and featureless spectra, strict lower limits on the redshifts can be inferred through observation of far-UV (FUV) absorption by the low-z IGM. This method has been applied to PG 1553+113, S5 0716+714, and

[9] Hubble Fellow.

Table 1
Intervening Lyman Absorption Lines

Line	$\lambda_{\rm obs}$ (Å)	$W_{\rm r}$[a] (mÅ)	b[b] (km s^{-1})	log N[c] (cm^{-2})	S.L.[d] (σ)
		$z = 0.5838$ system			
Lyβ	1624.6	89 ± 29	47 ± 7	14.18 ± 0.12	6
Lyγ	1540.2	73 ± 5	55 ± 8	14.52 ± 0.04	5
		$z = 0.5960$ system			
Lyβ	1637.1	180 ± 1	44 ± 3	14.52 ± 0.02	11
Lyγ	1552.1	60 ± 33	37 ± 5	14.44 ± 0.19	5
Lyδ	1515.7	19 ± 6	31 ± 5	14.3 ± 0.2	$\sim$2
		$z = 0.6035$ system			
Lyβ	1644.8	70 ± 11	14 ± 2	14.15 ± 0.06	7
Lyγ	1559.5	36 ± 10	15 ± 3	14.25 ± 0.08	4
Lyδ	1522.9	$\sim$13	$\sim$10	14.1 ± 0.3	$\sim$2

Notes.
[a] Rest-frame equivalent width.
[b] Doppler parameter.
[c] Corresponding column density.
[d] Line significance (according to Keeney et al. 2012).

3C 66A, showing lower limits of $z = 0.395$, 0.2314, and 0.3347 (Danforth et al. 2010, 2013; Furniss et al. 2013), respectively. We apply this technique to the VHE-detected blazar PKS 1424+240, constraining the blazar to $z \geqslant 0.6035$, making it the most distant VHE-detected blazar thus far.

2. OBSERVATIONS AND FAR-UV SPECTRAL ANALYSIS

PKS 1424+240 was observed under a *Hubble Space Telescope* (*HST*) program (12612; PI: Stocke) which uses flaring blazars as probes of intervening, weak IGM absorption. PKS 1424+240 is one of ∼200 objects monitored by a network of automated telescopes: the Katzman Automatic Imaging Telescope (KAIT; Filippenko et al. 2001), the "NF/Observatory" (Grauer et al. 2008), and the Small and Moderate-Aperture Remote Telescope System (SMARTS; Bonning et al. 2012). Optical photometry in 2012 April indicated that PKS 1424+240 was sufficiently bright to trigger a five-orbit *HST*/Cosmic Origins Spectrograph (COS) observation.

The blazar was observed on 2012 April 19, with the medium resolution ($\Delta v \approx 18\,{\rm km\,s^{-1}}$), FUV gratings G130M ($1135 < \lambda < 1450$ Å, 6.4 ks), and G160M ($1400 < \lambda < 1795$ Å, 7.9 ks). The flux-calibrated, one-dimensional spectra were obtained from the Mikulski Archive for Space Telescopes and combined with the standard IDL procedures described in Danforth et al. (2010). Additional analysis details are given in C. W. Danforth et al. (2013, in preparation). The combined data show a continuum flux level of $\sim 1.4 \times 10^{-14}$ erg cm^{-2} s^{-1} Å^{-1} and a median S/N per 7-pixel resolution element of ∼19 over the entire spectrum. The spectrum was normalized with an iterative, spline-based procedure and an automated line-finding algorithm was used to locate $>4\sigma$ absorption features (C. W. Danforth et al. 2013, in preparation).

We set a firm, observational lower limit to the source redshift by examining intervening absorbers. We see absorption consistent with higher-order H I Lyman absorption at $z \approx 0.6$ (Figure 1). The presence of absorption profiles consistent with Lyβ and Lyγ at three distinct redshifts provides unambiguous line identifications of absorbing gas along the line of sight (Table 1). The measurements summarized in Table 1 are made using Voigt-profile fits to the lines. The significance levels are calculated from the observed equivalent widths and flux errors and are calculated via the methods described in Keeney et al. (2012). The line identifications are bolstered in two cases by low-significance Lyδ detections.

In other cases where H I absorption is used to constrain blazar distance, the *lack* of absorbers past a certain redshift is used to place a statistical upper limit. For PKS 1424+240, the Lyα forest extends to the red end of the FUV detector (∼1800 Å; $z = 0.47$). Absorbers at higher redshift are detected through paired Lyβ and Lyγ lines visible at $z < 0.75$. However, this technique is less sensitive to H I absorbers than detection via Lyα, since both Lyβ *and* Lyγ lines must be detected to unambiguously identify an absorber and $(f\,\lambda)_{{\rm Ly}\gamma}$ is only ∼5% that of Lyα.

No H I absorbers are seen between the reddest system ($z = 0.6035$) and the red edge of the detector in Lyβ ($z = 0.75$) for a line-free path length $\Delta z = 0.15$. The spectral data quality is such that we should detect lines at log $N_{\rm HI} \gtrsim 14.0$ ($W_{{\rm Ly}\beta} \gtrsim 60$ mÅ, $W_{{\rm Ly}\gamma} \gtrsim 20$ mÅ) at a 4σ level. The frequency of lines of this strength or higher at low redshift is $d\mathcal{N}/dz \approx 24$ (Danforth & Shull 2008), so we would expect $\mathcal{N} = 3.5^{+3.1}_{-1.8}$ absorbers to be present if the source were at $z > 0.75$. Since no lines are seen, we can rule out $z > 0.75$ at approximately 2σ confidence. More detailed simulations may refine the redshift upper limit, but near-UV spectra and a direct search for Lyα lines at $z \sim 1$ will be less ambiguous.

The redshift lower limit is significantly higher than the conservative estimates of $z \geqslant 0.06$ (Scarpa & Falomo 1995) and $z = 0.23$ (Meisner & Romani 2010) derived from host-galaxy assumptions. Notably, the redshift estimates in Meisner & Romani (2010) are in close agreement with other blazar distance limits derived from the observation of absorption systems. The redshift limit for PKS 1424+240 is also below the upper limits of $z = 0.66$ and 1.19 derived from correcting VHE observations for EBL absorption to match the *Fermi* Large Area Telescope (LAT) data in Acciari et al. (2010) and Yang & Wang (2010), respectively.

3. ABSORPTION OF VERY HIGH ENERGY PHOTONS

The energy- and redshift-dependent absorption of VHE gamma rays by the EBL can be estimated using the model-specific optical depth, $\tau(E, z)$, where the absorption-corrected (deabsorbed) flux, $F_{\rm cor}$, is estimated from the observed flux, $F_{\rm obs}$, using the relation $F_{\rm cor} = F_{\rm obs} \times e^{\tau(E,z)}$. We investigate the deabsorbed VHE spectrum of PKS 1424+240 at the redshift lower limit of $z = 0.6035$, using three models to explore the effect of relatively low, medium, and high levels of EBL photon density. The lowest density model used is from Gilmore et al. (2012), which estimates a $z \sim 0$ EBL spectral energy distribution nearing the required lower limits on the EBL set by galaxy counts. We use the Domínguez et al. (2011) model to estimate VHE absorption by an intermediate-level EBL density and the Finke et al. (2010) model to represent a relatively high level of EBL density.

3.1. Constraining the Opacity of the EBL

The blazar VHE spectral index can be used to estimate the EBL spectral properties under the assumption that the intrinsic spectrum, characterized by the power-law $dN/dE \propto E^{-\Gamma}$, cannot be harder than $\Gamma = 1.5$, as described in Aharonian et al. (2006). The limit is physically motivated by the shock

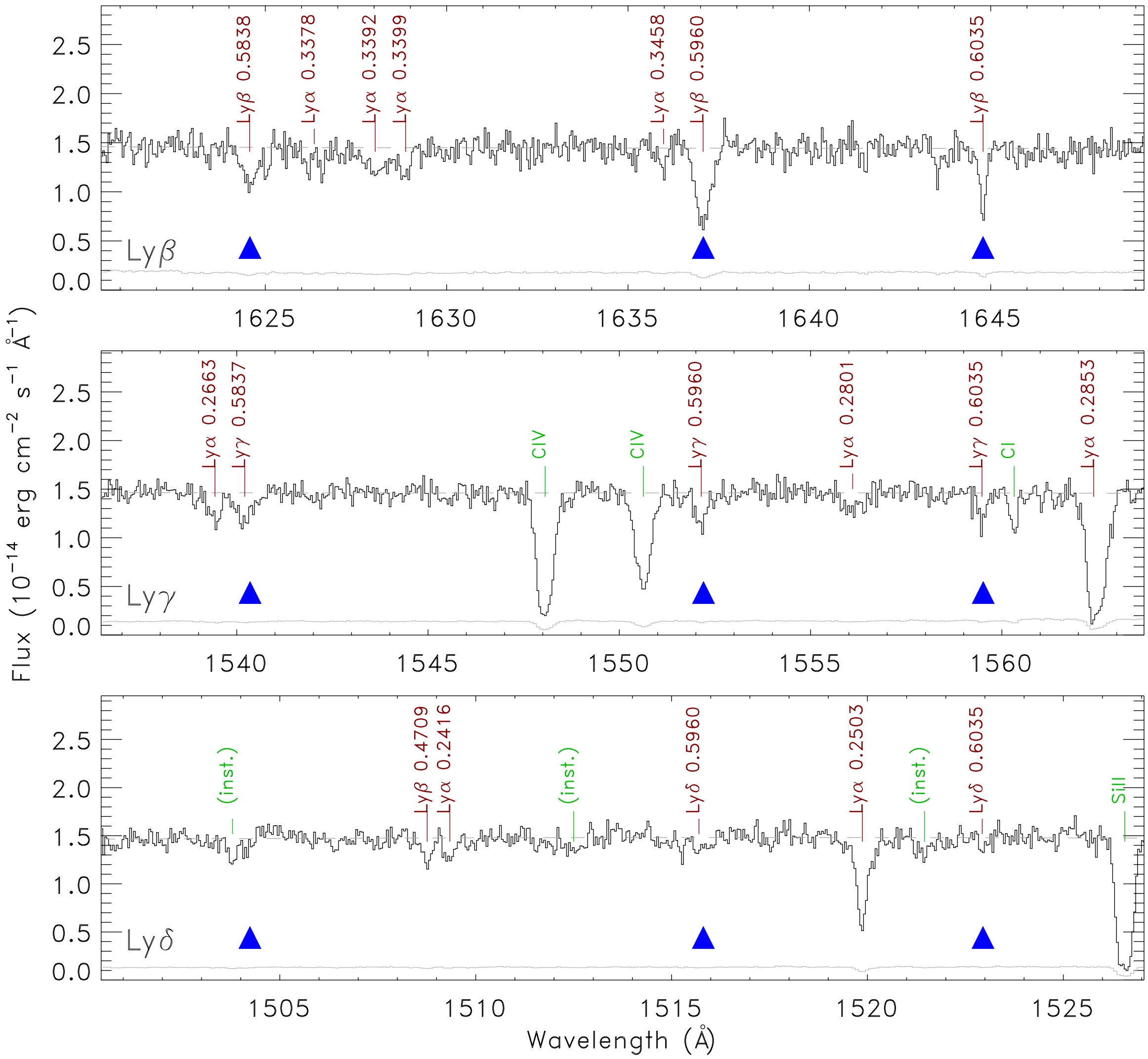

Figure 1. COS spectra show intervening absorption systems at $z = 0.5838$, $z = 0.5960$, and $z = 0.6035$ (arrows) toward PKS 1424+240 in Lyβ (1025.72 Å), Lyγ (972.54 Å), and Lyδ (949.74 Å). The COS flux and error (gray) vectors are binned by four pixels (half a resolution element). The continuum fit is shown with a dashed line. Other intervening absorption is identified with species and redshift in red. Lyα absorption systems are observed to the edge of the detector (1800 Å, corresponding to $z_{\mathrm{Ly}\alpha} < 0.47$). Galactic ($v \approx 0$) absorption and instrumental features are labeled in green. Lyα, Lyβ, and Lyγ features are detected at $\geqslant 3\sigma$ and will be discussed further in C. W. Danforth et al. (2013, in preparation).

(A color version of this figure is available in the online journal.)

acceleration paradigm, where the hardest index obtained for the accelerated leptons is 1.5.

Notably, the hardest blazar spectral index measured by the LAT has an index of 1.1 but is in statistical agreement with the theoretical limit (Ackermann et al. 2011; Nolan et al. 2012). Since the LAT is most sensitive to photons at energies where EBL absorption is negligible, the indices derived from LAT observations reflect the intrinsically emitted gamma-ray spectrum. A more conservative limit equal to the LAT-measured index can be placed under the assumption that blazars do not harden with increasing energy. For PKS 1424+240, the contemporaneous LAT-measured index is 1.80 ± 0.07 (Acciari et al. 2010; Figure 3).

A power-law fit can be applied to the absorption-corrected points for the redshift lower limit of $z = 0.6035$, as summarized in Table 2 for each of the EBL models. The fitted indices for the deabsorbed spectra using the relatively low and medium EBL models (Gilmore et al. 2012 and Domínguez et al. 2011, respectively) are well within the $\Gamma = 1.5$ and $\Gamma = 1.80 \pm 0.07$ limits. However, the $\Gamma = 0.6 \pm 0.8$ index resulting from deabsorption with the relatively more opaque model from Finke et al. (2010) is below, but still consistent with, either of the expectations. Improved gamma-ray observations may reveal that this model is too dense. Other explanations, such as time-dependent stochastic accelerated inverse-compton scenarios (Lefa et al. 2011a, 2011b) and internal gamma–gamma absorption (Aharonian et al. 2008), can also account for unusually hard VHE spectra.

3.2. The Gamma-ray Horizon

Intergalactic gamma-ray opacity due to the EBL has direct consequences for the estimation of the intrinsic gamma-ray spectra of extragalactic VHE targets, with the source-emitted flux being suppressed by $e^{-\tau(E,z)}$. This energy- and redshift-dependent flux suppression requires sources to be exponentially brighter at larger distances in order to be detectable at VHE.

The opacities probed through the VHE observation of blazars with redshift information provide insight into the possibility of a pair-production anomaly, as investigated in Horns & Meyer

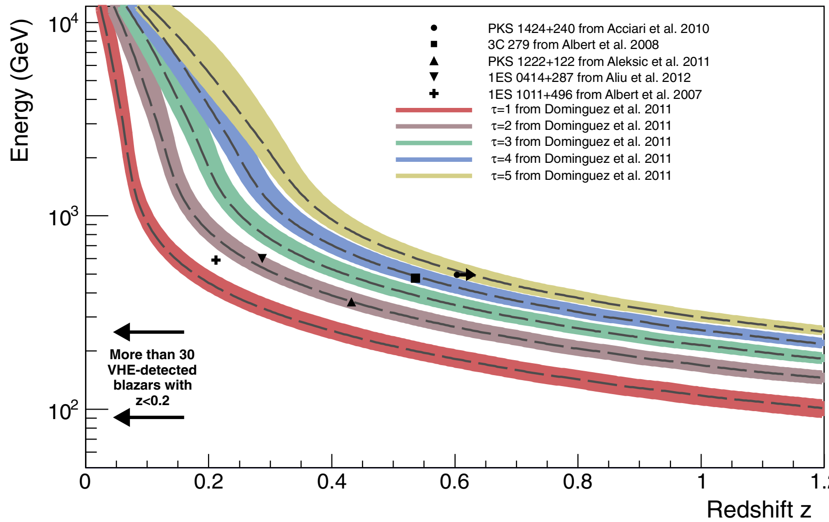

Figure 2. Highest-energy points of the VHE-detected blazars with published VHE data and spectroscopic redshifts beyond 0.2, as reported in Albert et al. (2008), Aleksic et al. (2011), Aliu et al. (2012), and Albert et al. (2007). The close proximity of VHE blazars is a result of the gamma-ray opacity of the universe. The $\tau = 1$–5 gamma-ray horizon contours are shown as bands, including model errors, representing the energy- and redshift-dependent $e^{-\tau}$ suppression of the VHE flux for extragalactic sources as calculated from Domínguez et al. (2011). The VHE detection of PKS 1424+240 is shown with a rightward arrow, indicating the redshift is a lower limit.

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Table 2
Results for the Power-law Fit to the Absorption-corrected VHE Points from Acciari et al. (2010) for $z = 0.6035$

EBL Model Used	VHE Range Deabsorbed Power-law Index Γ	$\tilde{\chi}^2$ (4 dof)	Full Range Deabsorbed Power-law Index Γ	$\tilde{\chi}^2$ (9 dof)	Full Range Deabsorbed Log-parabola Index Γ	Full Range Deabsorbed Log-parabola Curvature β	$\tilde{\chi}^2$ (8 dof)
Gilmore et al. (2012)	1.5 ± 0.8	0.85	2.07 ± 0.03	2.3	2.04 ± 0.04	0.10 ± 0.03	1.4
Domínguez et al. (2011)	1.0 ± 0.7	0.88	2.01 ± 0.03	2.0	1.99 ± 0.04	0.08 ± 0.03	1.5
Finke et al. (2010)	0.6 ± 0.8	0.83	1.97 ± 0.04	1.9	1.96 ± 0.04	0.07 ± 0.03	1.5

Notes. Additionally, we show the fits to the full range of data (0.5–500 GeV) for a power law ($dN/dE \propto (E/E_o)^{-\Gamma}$) and log parabola ($dN/dE \propto (E/E_o)^{-\Gamma-\beta \mathrm{Log}(E)}$). The fits for the Domínguez et al. (2011) model are shown in Figure 3 as blue dashed and dotted lines, respectively.

(2012). In the seven VHE blazar spectra that probe opacities in the range $1 \leqslant \tau \leqslant 2$, an upturn of the absorption-corrected spectra is apparent with a significance of 4.2σ at the $\tau \geqslant 2$ transition energy. Due to the different energies of the $\tau \geqslant 2$ transition for the blazars studied, source-intrinsic features are an unlikely explanation. This study was limited by the number of VHE blazars probing opacities $\tau \geqslant 2$ with known redshift. PKS 1424+240 can now be included in the study, expanding the limited opacity parameter space available.

Before the determination of the redshift lower limit of PKS 1424+240, the highest sampled gamma-ray optical depth probed was associated with the detection of 3C 279 during an elevated state, probing a $\tau(E = 475\,\mathrm{GeV}, z = 0.536) = 3.2$, 3.9, or 4.3 when estimated with the Gilmore et al. (2012), Domínguez et al. (2011), and Finke et al. (2010) models, respectively. Now, with PKS 1424+240, the highest opacity sampled is between 4.1 and 5.3 (if estimated with the Gilmore et al. (2012) and Finke et al. (2010) models, respectively.)

We show the highest opacity sampled by the VHE detection of 3C 279 compared to the opacity probed with the detection of PKS 1424+240 in Figure 2, as derived for the Domínguez et al. (2011) model. The spectral points are plotted along with the $\tau(E, z) = 1$–5 horizons. For reference, we also show published spectral points of every VHE-detected blazar with a spectroscopically measured redshift above 0.2 (four sources, as compared to the more than 30 VHE blazars with $z < 0.2$). Since the redshift of PKS 1424+240 represents a lower limit, the maximum opacity sampled by the VHE detection is illustrated with a right-pointing arrow.

4. ABSORPTION-CORRECTED GAMMA-RAY EMISSION

The observed gamma-ray peak is reproduced from Acciari et al. (2010) in Figure 3, illustrating the contemporaneous LAT and VERITAS data with black squares and circles, respectively. Additionally, we correct the observed VHE spectrum for EBL absorption at the minimum redshift of $z = 0.6035$ using the intermediate model (Domínguez et al. 2011), illustrated by gray circular points. Absorption of the LAT data is negligible.

The LAT and VERITAS gamma-ray observations extend from 0.5 to 500 GeV. This full range, when corrected for EBL absorption at $z = 0.6035$, is not well fit with a power law (dashed blue line), while a curved log parabola provides an improved fit (dotted blue line). We note that neither the power law nor the log-parabolic fit represents the data well. The fit results for each EBL model are summarized in Table 2. Both the power-law and log-parabolic fits find indices of $\Gamma \sim 2$, with a significantly curved log-parabolic fit. Notably, the highest energy VERITAS point at 500 GeV appears to deviate from the fits, matching the LAT extrapolated power law (red dashed line). This deviation

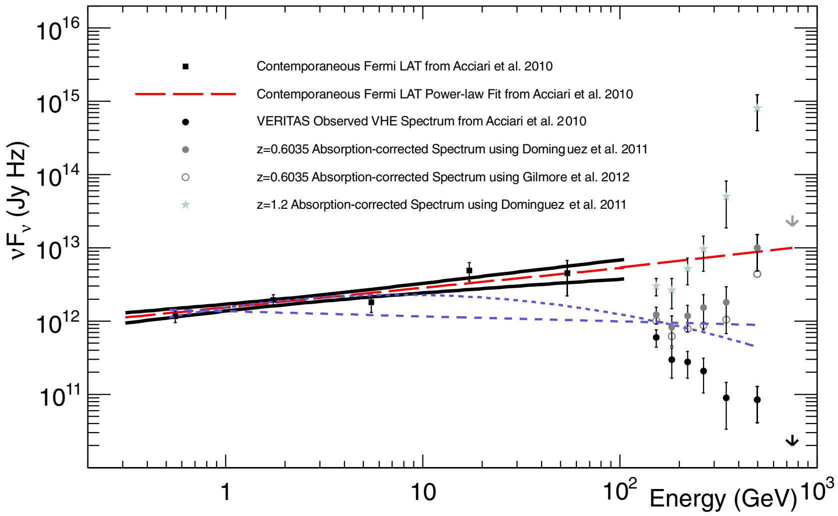

Figure 3. Gamma-ray peak of the spectral energy distribution of PKS 1424+240, with LAT (squares and power-law fit contour) and VERITAS observations (black circles) taken from Acciari et al. (2010). An upper limit at 750 GeV is shown with a downward pointing arrow. The LAT data have been selected to be contemporaneous with the VERITAS observations. The absorption-corrected VHE spectrum is shown with the gray circles, using opacities from the Domínguez et al. (2011) EBL model. For reference, the absorption-corrected points using the Gilmore et al. (2012) model are shown in open circles, with errors (not drawn) similar to those shown for the Domínguez et al. (2011) deabsorbed points. The LAT power-law fit has been extrapolated up to VHE (dashed red line). Power-law and log-parabolic fits to the full range (0.5–500 GeV) are shown in the blue dashed and dotted lines, respectively, with fitting results in Table 2. To bring the first absorption-corrected VERITAS spectral point to match the LAT observed spectrum, the blazar needs to be corrected for absorption expected for $z \approx 1.2$, shown by blue stars (the upper limit for this deabsorption is off-scale).

(A color version of this figure is available in the online journal.)

is not expected by standard blazar emission models, but is only about two standard deviations at the redshift lower limit.

A break between the LAT and VERITAS absorption-corrected data is apparent. This discrepancy is not likely an issue of instrumental cross-calibration, as agreement between VERITAS and LAT observations has been found for other contemporaneous blazar observations (e.g., Aliu et al. 2011, 2012). A portion of this feature may be due to a small level of undetected variability. Although short intervals of variability are difficult to rule out, no long-term variability is detected (Acciari et al. 2010), making it unlikely that the spectral feature between the LAT and VERITAS instruments is due to variability alone.

Since $z = 0.6035$ is a lower limit, it is conceivable that the discontinuity between the LAT and VERITAS data may in fact be an unphysical effect arising from the incomplete correction for absorption by the EBL. The first differential flux point of the VHE spectrum at 150 GeV cannot be made to match the LAT extrapolated spectrum without deabsorbing the flux for a redshift of 1.2 (blue stars in Figure 3). This deabsorbed spectrum is shown for the Domínguez et al. (2011) model, but is representative of the required distances of $z = 1.5$ and $z = 1.0$ when corrected with the Gilmore et al. (2012) and Finke et al. (2010) models, respectively.

The $z = 1.2$ corrected VHE spectrum results in a *rising* slope, i.e., with an index $\Gamma = -2.5 \pm 1.0$ when fit with a differential power law. A VHE spectrum with a rising power law is difficult to produce even in the most extreme emission scenarios. Although this redshift value is still in agreement with the redshift upper limit set by Yang & Wang (2010), we interpret the unphysical VHE spectrum as evidence that the blazar does not reside at this distance.

4.1. *Possible Signature of Intrinsic Gamma-ray Absorption*

Assuming that the blazar resides near $z = 0.6035$, the apparent discontinuity between the LAT and VERITAS energy ranges may be due to gamma-ray absorption in the vicinity of the blazar. It has been shown that absorption of gamma rays by a broad-line region (BLR) can produce broken power-law spectra in bright LAT-detected blazars (Poutanen & Stern 2010). However, this type of absorption is not immediately expected for an intermediate-/high-synchrotron-peaked source such as PKS 1424+240, expected to exhibit a clean radiation environment (Böttcher & Dermer 2002; Ghisellini et al. 1998).

The absorption-corrected VHE point at 500 GeV matches the LAT power-law extrapolation, with a distinct mismatch to the 100–400 GeV points. A source of gamma-ray opacity that is only sensitive to photons between 100 GeV and ∼400 GeV is difficult to explain with an ion continuum such as that present in a BLR. It has been shown that the optical depth of a BLR containing UV-continuum and ionization lines produces a constant optical depth from tens of GeV to beyond 30 TeV (Tavecchio & Mazin 2009). Since PKS 1424+240 is not expected to harbor a BLR, it is perhaps more likely that the EBL model is slightly overcorrecting for the photon absorption around 500 GeV. The observed hard spectrum might also be explained by secondary gamma rays produced in cosmic ray interactions along the line of sight (Essey & Kusenko 2010; Aharonian et al. 2008).

5. CONCLUSIONS

We present the strict redshift lower limit of $z \geqslant 0.6035$ for PKS 1424+240, set by the detection of Lyβ and Lyγ lines from intervening hydrogen clouds. This lower limit makes PKS 1424+240 the most distant VHE-detected source. At this distance, VHE observations of the source out to energies of 500 GeV probe gamma-ray opacities of up to $\tau \sim 5$.

An investigation of possible constraint on the opacity of the EBL shows that the absorption-corrected power-law fits do not lie significantly outside of the standard spectral limitations. However, deabsorption with the Finke et al. (2010) model produces the hardest intrinsic VHE spectrum. If the blazar resides at a redshift beyond the lower limit, the deabsorbed indices may become constraining to even the lowest level EBL model.

This redshift information allows the investigation of the EBL absorption-corrected gamma-ray emission. Correcting the VHE spectrum for the minimum redshift of $z = 0.6035$ shows an unexpected spectral shape. The elevated flux around 500 GeV, while not high significance, may be due to an overcorrection of absorption by the EBL model. This feature is still present when using the Gilmore et al. (2012) model (open circles in Figure 3), which predicts a low EBL density and therefore might be evidence for a pair-production anomaly, such as might occur if VHE photons mixed with axion-like particles.

The spectral feature occurring between the LAT and VERITAS energy bands cannot be reasonably removed by correcting for additional absorption due to a larger distance. Instead, deabsorption for a higher redshift to match the LAT and VERITAS fluxes results in a non-physical spectrum and an extreme distance of $z = 1.2$. It is possible, although unlikely, that the EBL absorption-corrected gamma-ray spectrum of PKS 1424+240 is exhibiting gamma-ray absorption within an intrinsic photon field such as a BLR. As the most distant VHE BL Lac object probing historically high values of gamma-ray opacity, this source requires additional gamma-ray observations and a tighter constraint on the redshift to further investigate the intrinsic emission.

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Facilities: VERITAS, *HST* (COS), *Fermi* (LAT)

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